

Extended producer responsibility for waste tyres in the EU: Lessons learnt from three case studies – Belgium, Italy and the Netherlands

Winternitz, Kim; Heggie, Mark; Baird, Jim

Published in:
Waste Management

DOI:
[10.1016/j.wasman.2019.04.023](https://doi.org/10.1016/j.wasman.2019.04.023)

Publication date:
2019

Document Version
Author accepted manuscript

[Link to publication in ResearchOnline](#)

Citation for published version (Harvard):

Winternitz, K, Heggie, M & Baird, J 2019, 'Extended producer responsibility for waste tyres in the EU: Lessons learnt from three case studies – Belgium, Italy and the Netherlands', *Waste Management*, vol. 89, pp. 386-396. <https://doi.org/10.1016/j.wasman.2019.04.023>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please view our takedown policy at <https://edshare.gcu.ac.uk/id/eprint/5179> for details of how to contact us.

Title:

Extended Producer Responsibility for waste tyres in the EU: Lessons learnt from three case studies – Belgium, Italy and the Netherlands

AUTHORS & AFFILIATION:

Kim Winternitz^a

^aGlasgow Caledonian University, Cowcaddens Rd, Glasgow G4 0BA, UK
Winternitz.kim@gmail.com

Mark Heggie^b

^bScottish Environment Protection Agency, Maxim 6, 4 Parklands Avenue, Eurocentral, North Lanarkshire, ML1 4WQ, UK
mark.heggie@sepa.org.uk

Jim Baird^a

^aGlasgow Caledonian University, Cowcaddens Rd, Glasgow G4 0BA, UK
J.Baird@gcu.ac.uk

CORRESPONDING AUTHOR: Kim Winternitz

E-mail: winternitz.kim@gmail.com

Permanent, full postal address: Dikke-Beuklaan 32/104; 1090 Jette – Belgium

DECLARATIONS OF INTEREST: none.

The views expressed are the views of the authors' alone.

FUNDING SOURCES: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

GRAPHICAL CONSIDERATIONS: Colour is not necessary in print

1 **ABSTRACT:**

2 The article compares the performance of three Extended Producer Responsibility (EPR) systems for tyres and
3 discusses the respective policy context that leads to these results. It aims to give insight into the varied
4 implementation of EPR policy through the presentation of case studies. The EPR systems for tyres in Belgium,
5 Italy and the Netherlands are described and common success factors as well as weaknesses are examined. The
6 systems mainly differ in respect of scope and targets for material and energy recovery. The presented case
7 studies assign physical (through a take-back obligation) as well as financial (through an advanced disposal fee)
8 responsibility to the producers. EPR for tyres has been found to reduce flytipping and illegal stockpiling of
9 tyres; increase resource efficiency by increased recycling; and move waste tyre management up the waste
10 hierarchy. It is found that best results for recycling are achieved, if the legislation sets quantitative targets and
11 clearly defines waste status of tyres to maximise local reuse/retread. It is argued however, that recycling is
12 favourable over reuse/retread in the case of waste tyres. The case studies show that an EPR system is no
13 guarantee for waste treatment in the most environmentally sound way. An EPR system will only achieve its
14 objectives if properly designed, implemented and enforced. If legislation allows, Producer Responsibility
15 Organisations will find the cheapest, not the environmentally most favourable, solution for waste
16 management.

17

18 **KEYWORDS:** Extended Producer Responsibility; Waste Tyres; Waste Policy; Belgium; Italy; Netherlands

19

20

21 Extended Producer Responsibility for waste tyres in the EU: Lessons learnt from three case
22 studies – Belgium, Italy and the Netherlands

23 1 Introduction¹

24 Extended Producer Responsibility (EPR) is a policy tool that is often put forward as an appropriate instrument
25 towards sustainable waste management of difficult to collect and treat waste streams. This article looks at the
26 experiences of waste tyre management with EPR in the EU.

27 2 Overview of EPR for waste tyres in the EU

28 EPR is the most common management system for dealing with waste tyres in the EU. Of currently 28 EU
29 member states, 21 are found to have implemented EPR (Bakas, 2013; EcoAnvelope, 2018; ETRMA, 2017a; Gov.
30 of the Rep. of Croatia, 2017; Monier et al., 2014; SektionV, 2017). Outside of the EU, Norway, Switzerland and
31 Turkey have EPR for waste tyres (ETRMA, 2017a). Beyond Europe, EPR for waste tyres becomes less popular,
32 but can still be found in most Canadian Provinces and some US States (SAIC Energy, 2012), as well as in South
33 Korea (WBCSD, 2010).

34 EPR is a policy approach where a producer's responsibility for a product is extended to the post-consumer
35 stage of the product's life cycle. The intention is to shift the physical and/or financial burden for end-of-life-
36 products from the authorities to the producer (Monier et al., 2014; OECD, 2001). Within EPR legislation,
37 regulatory and economic policy instruments are combined in order to enhance waste collection, reduce waste
38 through incentivizing eco-design, and increase resource efficiency through higher recycling rates, as well as
39 shift the cost for waste management from the tax-payer to the polluter (i.e. producer or end user of a product)
40 (Lindhqvist, 2000; OECD, 2001; Van Breusegem, 2009). The legal framework mostly consists of a take-back

¹ Abbreviations: ELT – end-of-life tyre; ELV – End-of-life vehicles; EPR – Extended Producer Responsibility; ER – energy recovery; EU – European Union; MR – material recovery; PRO – Producer Responsibility Organisation; R&D – Research & Development; UT – used tyres; WT – waste tyres

obligation (regulatory instrument) in combination with an advanced disposal fee (economic instrument) (see Supplementary Information).

The implementation of EPR systems for tyres within the EU is varied. Most producers collectively outsource their responsibilities under an EPR system to third parties that are non-governmental and mostly not-for-profit-organisations; so-called Producer Responsibility Organizations (PRO). As illustrated in Table 1, in most countries, a model consisting of one PRO whose members are producers as well as importers has evolved, although national EPR systems with two PROs, one founded by producers and one by importers (e.g. France and Spain) can be found. Furthermore, individual schemes where a producer/importer does not outsource its responsibilities under EPR legislation, but implements them itself, also exist. The Italian legal framework prohibits individual schemes, resulting in a system with 37 PROs. Hungary and Croatia feature the only two governmentally implemented systems substituting PROs. They assign financial responsibility to the producers and the governmental bodies execute the activities usually undertaken by PROs (EEA, 2016; Gov. of the Rep. of Croatia, 2007).

Technical performance regarding collection and treatment is varied as well. While some systems have high collection rates of 100% or over², others are less successful. Treatment rates may vary significantly between member states. Figure 1 features used tyres, material recovery, energy recovery and landfill/unaccounted rates per country. Used tyres combine locally reused/retreaded tyres as well as those exported for reuse/retread. For this article, reused tyres are understood as tyres that can be reused for their original purpose without further treatment. Retread tyres are taken as tyres that can only be reused for their original purpose after their tread is renewed, i.e. they are retreaded. Material recovery (MR) includes tyres subjected to recycling, civil engineering, public works and backfilling operations as well as 25% of weight of tyres incinerated in cement kilns. Energy recovery (ER) includes tyres subjected to thermal treatment for power

² Collection rates of more than 100% are caused by reuse and retread tyres, which are counted once when entering the tyre replacement market as a new tyre, but counted repeatedly at the waste stage, as a tyre can be reused and retreaded more than once.

63 and/or heat generation, co-incineration processes as well as pyrolysis. Tyres in the category
64 Landfill/unaccounted are either landfilled or represent gaps in the data where more new tyres are put on the
65 market than waste tyres are accounted for. The terms are identical with ETRMA's (European Tyre & Rubber
66 Manufacturer's Association) use of terms, as the data used in this study depends on these. However, ETRMA's
67 definitions do not necessarily correspond to EU definitions (Van Breusegem and Gonser, 2017). In order to
68 assess if and how the design of policy influences treatment performance, three case studies are compared.

69 *Table 1 Number of PROs per EU-Member State (EPR – Extended Producer Responsibility; PRO – Producer Responsibility Organization)*

70 *Figure 1 Waste tyre treatment under Extended Producer Responsibility in the European Union in 2015³*

71 **3 Methodology**

72 Research has been conducted in two steps. First, a broad analysis was conducted on all EU EPR systems for
73 tyres through an extensive literature review. A general overview was compiled containing the use of economic
74 and regulatory policy instruments within the respective EPR (see Supplementary Information). Information on
75 treatment rates was derived from data consolidated by ETRMA, which is consolidating data on waste tyre
76 treatment within the EU. ETRMA draws on various sources such as official national reports, Eurostat, ETRMA
77 members, local authorities, other industry bodies (e.g. cement industry) or associations (Europool), PROs, etc.
78 The consolidation of all these various data sets leads to an extensive database on waste tyre arising and
79 treatment for the EU and associated countries (ETRMA, 2018). Based on the overview, three countries that
80 have managed to move their waste tyre treatment up the waste hierarchy, have been selected for detailed
81 analysis: Belgium, Italy and the Netherlands.

82 Second, detailed case studies of the selected countries were conducted, based on personal interviews and
83 additional literature. Interviews were conducted as free conversations based on a mix of open and tailored
84 questions in order to fill information gaps in the literature as well as to enable the interviewees to speak as
85 freely and give as much information as possible. The questions were tailored to the stakeholder and country

³ Countries marked with * have not yet had a functioning EPR for tyres in 2015.

specific questions were added (see Supplementary Information). Interviews were conducted with key experts from regulators and organisations representing municipalities. Regulators were consulted as the designers of the legal framework and main monitoring bodies. The Italian public authority interviewed is involved in the system as the monitoring body, while the Flemish public authority interviewed (OVAM, Public Waste Agency of Flanders) monitors the system's implementation as well as designs the policy and negotiates agreements with the sector. Municipalities were consulted as indicators for the success of a system. Before the implementation of EPR for tyres, municipalities were financially and physically confronted with the treatment of waste tyres. Thus, municipalities should be financially as well as physically completely freed from waste tyre management under EPR. Associations representing the municipal sector on waste management have been consulted, in order to represent the wider view of municipalities (NVRD – Royal Dutch Solid Waste Association for the Netherlands; VVSG - Association of Flemish Cities and Towns for Flanders). The case studies were mainly supplemented by data from PRO websites and annual reports.

The research focus is set on the design, implementation and enforcement of policy. Economic data has intentionally been omitted for two main reasons:

- 1) Economic data is elusive because of the commercial sensitivities in the often market based approaches.
- 2) Economic data associated with fee structures is not directly comparable, as it depends on factors external to the EPR system. Such factors may vary locally such as population density; topography; value of secondary materials or participation in the system (Monier et al., 2014). Furthermore, different services may be included in the fee.

Thus, including fees has the potential to mislead the reader and might lead to rash conclusions that one system may be more cost effective than the other, rather than adding valuable insight to the functioning of the researched EPR systems.

109 4 Case Studies

110 *Figure 2 Waste tyre treatment in Belgium, Italy and the Netherlands*

111 4.1 Belgium

112 Belgium introduced its EPR for tyres in 2004 and is managing an average 78,000 tonnes of waste tyres
113 annually, with recent collection rates above 100% (Recytyre, 2016, 2015, 2014). An average material recovery
114 rate of 85% and an energy recovery rate of 15% is being achieved and as such, the Belgian system has
115 exceeded its legal targets (see Figure 2).

116 Belgium is a federal state with three regions (Flanders, Wallonia and the Brussels Region). Trade and economy
117 are federal competences whereas environment is a regional competence. While waste policy is designed,
118 enforced and reported on a regional level, policies regarding products are handled on a federal level. Thus,
119 there are not only potential discrepancies between federal and regional policies, but also between the regions.
120 In the case of EPR for tyres, each region has a separate environmental policy agreement with Recytyre, the
121 only PRO for tyres operating in Belgium. Despite this, there are no differences in collection and treatment
122 targets (OVAM, 2018; VVSG, 2018). Within Belgium, Flanders was the first region to implement EPR for tyres.
123 Only Flemish legislation is therefore further described to represent Belgium.

124 4.1.1 Legal Framework

125 The primary motivation to introduce EPR for tyres in Flanders was to reduce illegal disposal. Secondary goals
126 were to incentivize eco-design and waste prevention (OVAM, 2018). The legal framework in general, and EPR
127 for tyres in particular, is given by the Materials Decree and its executive order VLAREMA. These define the
128 producer as manufacturers and importers of tyres including online sellers. They enforce the take-back
129 obligation and advanced disposal fee in the form of a visible fee (OECD, 2016). Tyres are commercial waste,
130 meaning municipalities are not obliged to collect them. However, many municipalities voluntarily collect tyres,
131 as they believe rejecting tyres potentially incentivizes illegal disposal (VVSG, 2018).

132 The Materials Decree further defines the framework for the so-called *environmental policy agreements*. These
133 are negotiated between the regulator and the tyre sector and contain the practical implementation of the
134 take-back obligation and specify targets for collection, material recovery and energy recovery. The agreement
135 is renegotiated every five years. The latest Flemish agreement expired in 2015 and contained the following:

- 136 • Tyres from original equipment included in scope;
- 137 • Collection target of 100%;
- 138 • Treatment targets:
 - 139 ○ Minimum 55% material recovery (including reuse and retread);
 - 140 ○ Maximum 45% energy recovery.

141 Currently there is no new agreement due to disputes with private collectors (OVAM, 2018).

142 Legislation does not specify how producers implement their responsibilities and gives them room to organize
143 themselves individually as well as collectively through one or several PROs.

144 4.1.2 Implementation: The Recytyre Scheme

145 Within Belgium only one PRO (Recytyre) has been established by producers, and only one individual scheme is
146 currently operating in Flanders (OVAM, 2018). Recytyre reports to the relevant public authority in each of
147 Belgium’s regions. It has about 750 members and finances itself through membership fees (Recytyre, 2018).
148 Management of waste tyres is paid through a visible fee, which is calculated by Recytyre and approved by
149 the regional public authority. The visible fee is paid for new tyres by the consumer at the time of purchase.

150 The fee covers:

- 151 • Collection and treatment of tyres;
- 152 • Waste tyre prevention programmes;
- 153 • Communication to the public on the scheme;
- 154 • Administration of the PRO (OVAM, 2018).

155 Clean-up cost for illegally disposed tyres is not included and is thus covered by municipalities, i.e. the tax-payer
156 (VVSG, 2018). Historical stocks are partially included in the system and cost for disposal is shared between the
157 PRO, the regional authority and the owner of the stock (OVAM, 2018).

158 Recytyre organises the collection of waste tyres. Collection points mostly are points of sale for tyres (garages
159 and tyre retailers), which register with Recytyre. Only about 5,000 tonnes annually are collected from
160 municipal civic amenity sites. Municipalities participating in the Recytyre scheme receive financial
161 compensation (€ 35/tonne), which is not entirely cost covering. The “1-for-0”-principle applies for collection
162 points, i.e. waste tyres must be accepted even if no new tyres are purchased. This is capped by four tyres per
163 household annually (VVSG, 2018). Recytyre directly contracts with private collectors, who collect tyres and
164 transport them to approved treatment facilities. It is up to the collector to choose which facility. The targets
165 for material and energy recovery are outsourced to the collectors. Recytyre’s payment policy to waste
166 collectors is unique among Belgium’s EPR systems: An independent consultancy calculates the cost for
167 collection and treatment of tyres, which is then offered to collectors.

168 4.1.3 Evaluation

169 A strength of the Belgian system are the environmental agreements between the sector and the government.
170 They are an inclusive way of engaging the sector and they allow for flexibility in the adjustment of the content
171 of the EPR system. Every five years the agreement is renegotiated, which is an opportunity to adjust targets as
172 well as the scope. Operating the system through agreements has made it possible to evolve the EPR system
173 and gradually include tyres from original equipment and partially historical stocks. It has also been possible to
174 phase financial compensation of municipalities for collected tyres.

175 However, this system also bears a threat to the entire EPR system for tyres. The formation of the new
176 environmental agreement is currently stalled by waste collection companies. The conflict is rooted in the
177 collectors’ view that their profit margins are being eroded by Recytyre’s pricing policy. In a free market system
178 collectors contract individually with collection points (mainly garages), giving the collectors control over the

price for collection. Under EPR legislation the PRO contracts with the collectors, not the collection points. This changes the influence collectors have during negotiations. Collectors currently face a united block of producers and garages. Previously, Recytyre has tendered collection, but this frequently led to collectors contesting decisions in court. Thus, Recytyre now have an independent consultancy calculate the cost for collection and treatment in order to offer a fair, fixed price for both Recytyre and the collectors. Collectors can then decide to collaborate for that price or not. However, at the present time collectors are not content with this solution and are currently lobbying against the EPR system at a political level. This has led to a situation where the new environmental agreement is currently not even at a draft stage after the previous one expired in 2015. In the meantime Recytyre continues its operations under the conditions of the previous agreement (OVAM, 2018; VVSG, 2018).

The implementation of EPR systems through agreements is a common feature in all Belgian EPR systems and is generally regarded as a good model by each sector, as they have an influence on the targets. Only the EPR for tyres is currently under threat. However, there is criticism towards the model, as it puts the government into a weak negotiation position by being dependant on the agreement of the private sector. One option to avoid such situations would be to increase legislative leverage by legally imposing a deadline for reaching an agreement. If no agreement can be reached after a fixed amount of time, the government would be able to impose conditions (VVSG, 2018).

Relatively high material recovery rates and a sharp decrease of illegally disposed tyres (OVAM, 2018; VVSG, 2018) make the Belgian system a success from a treatment point of view. However, the difficulties in establishing a new environmental agreement point to weaknesses in the legal framework.

4.2 Italy

Italy introduced its EPR for tyres in 2011, annually dealing with about 444,000 tonnes of waste tyres including historical stocks. The introduction of EPR had a significant impact on the material recovery rate, which more than doubled in the first three years of the EPR system (see Figure 2).

203 Since the introduction of EPR, illegally disposed tyres, which constituted a quarter of tyres put on the market
204 in 2010, have steadily decreased (Torretta et al., 2015). Currently, the collection rate is estimated at 90%
205 (Public Authority⁴, 2018).

206 4.2.1 Legal Framework

207 The primary objective for implementing EPR for tyres in Italy was to boost national recycling rates. Many EU
208 countries already had implemented EPR for tyres and the Italian regulator viewed the EPR approach as an
209 effective means of improving recycling rates (Public Authority, 2018). The Italian EPR for tyres is mainly
210 defined by the *Ministerial Decree no. 82*. It outlines a take-back obligation accompanied by an advanced
211 disposal fee in form of a visible fee. The only target outlined is for collection and specifies that producers are
212 obliged to collect 100% of tyres corresponding to tyres introduced to the market in the previous year. If
213 collection targets are not met or reporting is flawed, penalties based on the visible fee are imposed. The
214 highest penalty is for free-riding⁵, which amounts to 200% of the fee for tyres put on the market illegally. In
215 case the minimum collection target is not met, the penalty is 150% of the fee for the uncollected amount of
216 tyres. Wrong reporting is fined with 15% and late reporting with 5% of the corresponding fee per detected
217 breach.

218 The decree clearly defines tyres to be waste only when tyres have reached end-of-life status. In Italy it is the
219 garage itself that is regarded as the main producer of waste tyres and not the car or vehicle owner, who is the
220 one generating waste. The garages are the ones making a decision about the tyre's extended use or end-of-
221 life. If a tyre is eligible for neither reuse nor retread, it is an end-of-life tyre (ELT) and handed over to the waste
222 collectors, at which point the tyres legally become waste (Gov. Italy, 2011) (see Figure 3).

223 The fee is determined by the regulator. On an annual basis, each PRO submits the cost for ELT management
224 within their scheme, which forms the base for establishing the fee. Clean-up cost for illegally disposed tyres is

⁴ The interviewee, employed at a relevant Italian public authority, wished to remain anonymous.

⁵ Free-riders are producers of tyres that neither participate in a collective EPR scheme, nor individually take up their responsibilities.

not included in the fee, and municipalities are not compensated for collection. Hence, some of the financial burden of waste tyre management remains with the tax-payer (Public Authority, 2018).

Italian legislation stipulates that structures dealing with waste tyres must be legally independent entities (Gov. Italy, 2011). Thus, producers executing their responsibilities individually, must form a PRO as well. This leads to a system with currently 37 PROs, where some represent only one producer, and others represent multiple. Furthermore, any business selling tyres, regardless of its size, must be a member of a PRO, as sales and import permits are only issued upon proof of PRO-membership. This further means that every garage selling tyres is a member of a PRO. This ensures full coverage for collection (Public Authority, 2018). If necessary, PROs can use historical stocks to reach their annual collection targets. Furthermore, at least 30% of a PRO's financial surplus must be dedicated to the removal of illegal or historical stocks (Gov. Italy, 2011).

Figure 3 Waste status for tyres according to Italian legislation (ELT – end-of-life tyre; ELV – end-of-life vehicle)

4.2.2 Implementation: The Ecopneus Scheme

Italy currently has 37 PROs. The largest is Ecopneus whose members represent 70% of the replacement tyre market. The second largest is Ecotyre with a market share of 20% (Public Authority, 2018). The remaining 35 PROs share the remaining 10% of the market. These are most likely individual schemes represented by their individual PRO.

Ecopneus was founded by tyre manufacturers and manages approx. 250,000 tonnes of ELTs annually. It contracts directly with collectors and treatment facilities. Collectors do not sort tyres for reuse or retread, as this is being done by collection points. Collected tyres are shredded and then 62.5% are sent for energy recovery and 37.5% to material recovery (Ecopneus, 2018). These values are contrary to national figures, where 56.5% go to material and 43.5% go to energy recovery. On a national level, this means that Ecopneus is responsible for 25.3% of material and 42.1% of Italy's energy recovery from waste tyres (Ecopneus, 2018; ETRMA, 2017b).

On the basis that reported recovery rates are accurate, Ecopneus is almost solely responsible for the energy recovery from waste tyres. This in turn means that the relatively small 36 remaining PROs account for the majority of material recovery rate, operating on an environmentally more desirable level than Ecopneus.

4.2.3 Evaluation

The Italian EPR system’s legislation exhibits a high degree of clarity. It states that tyres become waste after garages deem them not to be reusable. This leads to a financial incentive for garages, clearly encouraging them to sort out reusable tyres for re-sale (Gov. Italy, 2011). From the three case studies, Italy has the highest local reuse and retread rates (see Figure 2), pointing to the success of this practice.

The Italian EPR system is the only one of the case studies including historical stocks. Collection is based on a “1-for-1” principle, meaning collection points are only required to accept a waste tyre in return for a sold tyre. In combination with historical stocks being permitted for reaching the collection target, this means that a historical waste tyre potentially forces out a current waste tyre from collection. Legislation on one hand clearly counteracts the threat of cherry-picking implied by historical stocks included in collection targets. On the other hand, it assigns 30% of PROs’ profits to the clean-up of historical stocks (Gov. Italy, 2011).

In a system with 37 PROs, complete reporting and hence transparency and traceability of the material flow of waste tyres is of high importance. This is reflected in the legislation by penalties not only for the lack of, but also on incomplete reporting. However, there still is leakage of material (Public Authority, 2018), showing how challenging oversight can be in a system with multiple PROs.

Italy’s comparably high energy recovery rates, with much of waste tyres being subject to co-incineration in cement kilns, points to a dependency on cement production. Coupling the waste tyre market to the cement market, opens it up to vulnerability. Material recovery is regarded as a more robust outlet market for waste tyres due to its diversity (Bell and Cave, 2010; Boyle, 2012; Huang and Tang, 2009; Martínez et al., 2013; Scott, 2016; Sienkiewicz et al., 2012; WBCSD, 2010). Italy has legislative targets only in regards to collection. The

introduction of separate material recovery targets, perhaps combined with a cap on energy recovery, may diversify the waste tyre end market, as well as improve the system's entire environmental performance by promoting material recovery.

The Italian EPR for tyres has succeeded in reducing illegally disposed tyres into the environment (Public Authority, 2018). However, as the initial aim was to boost recycling targets, the EPR system has been less successful, as energy recovery rates remain relatively high. The legal requirement of PRO membership intensifies administration by the regulator and potentially leads to difficulties in consolidating information and tracking the waste flows by the competent authority. However, it nearly eradicates free-riding.

4.3 The Netherlands

Legislation for waste tyres in the Netherlands dates back to 1995. By the year 2000 the EPR system was in full operation. On average, the Netherlands annually deal with 89,000 tonnes of waste tyres (see Figure 2).

4.3.1 Legal Framework

The current EPR for tyres was enforced in 2004, which replaced the initial legislation from 1995. Its objective is the environmentally friendly collection and processing of waste tyres (RecyBEM, 2013). Only tyres from light vehicles of up to 3.5 tonnes and tyres from trailers are within the scope of the Dutch EPR system (Gov. NL, 2009). Much like the Belgian legislation, the Dutch legislation is not clear as to when exactly a tyre becomes waste. Collectors are in charge of sorting out reusable and retread tyres, but it is likely that garages do so too.

Producers are free to organize themselves either collectively (through a PRO) or individually. While a legal target for material recovery and reuse is 20% and a collection target of 100% is implied (RecyBEM, 2013). The Dutch EPR is implemented through a take-back obligation with an advanced disposal fee in the form of a visible fee. Collection points are mainly garages, which are obliged to take back tyres on a "1-for-1"-basis. Only since 2003/2004 has RecyBEM, the Dutch PRO, collected tyres from municipal civic amenity sites. Previously tyres were exclusively collected at garages. As tyres are regarded as commercial waste, municipalities are not

294 obliged to collect them, but some voluntarily do so. Those that do collect tyres can either collect them mixed
295 or in two streams:

- 296 • tyres within the scope of the EPR system;
- 297 • tyres not covered by the EPR system.

298 The former are typically collected for free by the municipalities. For the latter, municipalities may choose to
299 charge a disposal fee. This is a reflection of RecyBEM's collection policy: Tyres within the scope of the EPR
300 legislation are collected for free from municipalities under the condition that they are structurally sound and
301 clean. The collection of all tyres that are not covered by the EPR legislation is charged to the municipalities.
302 Municipalities are financially not compensated by RecyBEM for the collection of tyres within the scope (NVRD,
303 2018).

304 The regulator, the Dutch Inspectorate for Environment and Transport, periodically approves RecyBEM's
305 scheme. Upon approval, the scheme, and in particular its applied fee, receives lawful status. The fee then is
306 applied to the entire system (NVRD, 2018), meaning all individual schemes indirectly adhere to RecyBEM's
307 pricing policy.

308 Free-riders are reported to the regulator. However, there is a general lack of enforcement towards free-riders
309 within Dutch EPR systems. The sector is reluctant to report free-riders and free-riding is not a priority for the
310 regulator (NVRD, 2018).

311 4.3.2 Implementation: The RecyBEM Scheme

312 The only collectively implemented scheme for waste tyres follows a three component management system.
313 The implementing arm is RecyBEM which was set up by the *Dutch Tyre Association* in 2004. RecyBEM's
314 members are represented by the *Dutch Tyre Association*, who individually pay the advanced disposal fee to the
315 *Dutch Tyre and Environment Foundation*, which in turn funds RecyBEM (RecyBEM, 2013). The *Foundation*
316 functions as a black-box, keeping each producer's individual financial contribution to the EPR scheme

317 confidential. This is done in order to keep economically sensitive data such as market share confidential.
318 Without the black-box conclusions on the market share of a company could be drawn from the financial
319 contribution to the EPR system (NVRD, 2018).

320 RecyBEM contracts with collectors and treatment facilities directly. It voluntarily exceeds the legal minimum of
321 20% material recovery including reuse and retread and successfully targets a material recovery and reuse,
322 retread rate of 90% of tyres collected (RecyBEM, 2013). RecyBEM achieves the highest reuse and retread rate
323 in the EU.

324 RecyBEM and ARN, the PRO operating the end-of-life vehicles EPR system, cooperate in using a special tool to
325 assess waste tyre treatment options in regards to three key indicators:

- 326 • Ecology (savings of CO₂ equivalent),
- 327 • Resource efficiency (recycling), and
- 328 • Economy (cost of process).

329 These key indicators are determined by a policy decision making tool called Ecotest. Which is not an academic
330 life cycle assessment study, but a decision making tool based on life cycle assessment principles. It follows the
331 ISO 14040 series and uses SimaPro software for calculating. Ecotest mainly relies on real-life data from all
332 entities involved in the waste tyre treatment process in the Netherlands and strives to limit its use of data
333 from the Ecoinvent database (Ecotest, 2013). The real-life data used is not publicly available due to
334 confidentiality (RecyBEM, 2019).

335 The functional unit is a passenger car tyre with an average service life of 50,000 km over a four-year period
336 taken from an attributional Life Cycle Assessment conducted by Continental (Silke Krömer et al., 1999). Based
337 on this unit, each treatment option is studied as a chain, starting from collection and ending at the point
338 where the end-product of the treatment replaces a primary resource or fuel, while considering transport

339 throughout the chain. This results in an attributional approach where the considered and compared treatment
340 options are as follows:

- 341 • Retreading is compared to the casing of a new tyre with virgin styrene butadiene rubber. Whereas it is
342 assumed that each tyre can only be retreaded once.
- 343 • Export for reuse is compared to one newly produced tyre. It is assumed that the lifetime of the tyre is
344 extended by 20%, equalling 20% of saved primary resources compared to a new tyre. The impact of
345 the waste treatment option in the importing country is not accounted for.
- 346 • Incineration of tyres in a cement kiln is compared to incineration of hard coal, petcoke and iron ore;
- 347 • Incineration of tyres in a combined heat and power plant is compared to incineration of hard coal and
348 iron;
- 349 • Recycling is split into:
 - 350 ○ Textiles and residues going to incineration, thus compared to hard coal and iron;
 - 351 ○ Steel going to secondary steel production, thus substituting primary steel;
 - 352 ○ Rubber is compared to styrene butadiene styrene in bitumen when recycled as an additive to
353 asphalt, and to synthetic rubber (ethylene propylene diene monomer rubber) when used in
354 sports fields or as rubber tiles.

355 The environmental impact of the secondary products' waste treatment is only considered, if they
356 undergo a different waste treatment process than their alternatives sourced from primary
357 materials.

358 The composition of tyres is taken from the information provided by local recyclers.

359 Based on the indicator of ecology, the other two key indicators (resource efficiency and economy) are
360 calculated. From a cost perspective, only total cost for collection, sorting and recycling minus income from the
361 sale of reusable tyres, are considered (ARN advisory and FFact, 2011).

Ecotest’s results (see Table 2) show that export for reuse/retread is the environmentally least favourable, but financially cheapest treatment option. Yet on average 83% of reuse and retread tyres in 2010, 2014 and 2015 have been exported (see Figure 2), putting the success of high reuse and retread rates into perspective.

Table 2 Life Cycle Assessment (LCA) evaluation of treatment methods in the Netherlands

4.3.3 Evaluation

RecyBEM appear to be increasingly pursuing export of waste tyres for reuse and retread (see Figure 2). As mentioned above, this is the most economical, but not most environmentally friendly treatment. The tyres are likely to be exported outside of the EU, mainly to Africa (NVRD, 2018), meaning that they reach their end-of-life in countries with less stringent waste legislation and no landfill ban on tyres. The consequence of which may be that those tyres are managed in an even less environmentally friendly way at the very bottom of the waste hierarchy.

The difference in scope in the Dutch system compared to the others (see Table 3) make the system of questionable success, as most tyre types are not covered by the EPR system and thus have the potential to end up in the environment and to remain a financial burden to the municipalities. In addition, the lack of integrating historical stocks and putting the financial responsibility for their management on the entity discarding them, may further incentivize illegal disposal.

The Dutch treatment rates may be seen as only partially successful as well. While they are a success, due to high reuse and retread rates, those rates are dependent on export, which is reflected in its relatively low carbon emission savings.

381 5 Comparison of Case Studies

382 5.1 Common Characteristics

383 5.1.1 Common Success Factors

384 The case studies described are those EPR systems which best promote managing tyres higher up the waste
385 hierarchy within the EU. In all three, the responsibility allocated to the producer is not purely financial, but
386 also physical. The PROs directly contract with collectors and influence the treatment process as well. This has
387 been achieved by combining regulatory as well as financial instruments in the form of a take-back obligation
388 with a 100% collection target (regulatory) and advanced disposal fee as a visible fee (economic). The use of
389 infrastructure is also similar in the case studies. Not new infrastructure, but new logistics through existing
390 infrastructure for collection have been set up by all systems. The main points of collection are garages or tyre
391 retailers. In all systems, municipalities continue to collect tyres on a voluntary basis, but not many tyres are
392 collected through this path. PROs contract with private collectors who deliver the tyres to mainly private
393 treatment facilities. The degree of involvement in the treatment differs: Both Recytyre and RecyBEM have a
394 pool of approved treatment facilities, from which collectors can choose. But while Recytyre (Belgium) entirely
395 outsources the treatment targets to its collectors, RecyBEM (Netherlands) is more involved in the process.
396 Italy's Ecopneus has much control over organizing the treatment of waste tyres.

397 5.1.2 Common Weaknesses

398 Within all case studies part of the financial burden remains with the tax-payer, as some of the management
399 cost of waste tyres is left to the municipalities. Neither environmental fee covers clean-up costs for illegally
400 disposed tyres in full, and only the Belgian system partially compensates municipalities for collection.
401 None of the interviewed stakeholders believe their respective EPR system fosters eco-design, as to tyre design.

402 5.1.3 Common Challenges

403 EPR systems are generally challenged with handling free-riders and historical stocks. Free-riders are producers
404 of tyres that neither participate in an EPR scheme, nor individually take up their responsibilities. While their
405 tyres are sold on the national market, other producers participating in a scheme meet the costs of their waste
406 tyres. Within the Belgian and Dutch systems, the usual procedure is for PROs to detect and report free-riders
407 to the regulators who then are tasked to prosecute (NVRD, 2018; OVAM, 2018; VVSG, 2018). Within the Italian
408 system PROs are not involved in the detection of free-riders. Free-riding is almost impossible, due to legally
409 linking sales permits to PRO membership, (Public Authority, 2018). However, a prerequisite for such a practice
410 is active collaboration between the competent authorities, i.e. the ministries in charge of waste management
411 and trade.

412 The management of historical stocks significantly differs across the case studies. While they are completely
413 excluded in the Netherlands, the Belgian system partially and the Italian system completely includes them.

414 5.2 Main Differences

415 5.2.1 Differences in Scope

416 None of the case studies have the same scope. While Belgium and Italy are comparable, the Dutch EPR system
417 is limited to tyres from light vehicles (up to 3.5 tonnes) and their trailers only.

418 5.2.2 Differences in Targets

419 While all systems have collection targets of 100%, only Belgium and the Netherlands have a target for material
420 recovery. Belgium has an additional cap on energy recovery. None have separate reuse and retread targets, as
421 Belgium and the Netherlands include them in the material recovery targets.

422 *Table 3 Comparison of Scope and Targets of the Belgian, Italian and Dutch Extended Producer Responsibility for tyres legislation (ELV –*
423 *end-of-life vehicles)*

424 *Figure 4 Comparison of treatment rates in Belgium, Italy and the Netherlands*

425 It seems that targets are reflected in the performance of the system. When comparing reuse and retread
426 rates, export is singled out, as it has a significant impact on environmental performance. This is proven by the
427 Dutch case. Reuse of tyres within the EU is limited due to an EU-wide minimum tread depth of 1.6mm for
428 passenger car tyres (European Council, 1989). It is suspected that this is the reason why the Netherlands
429 export a high number of tyres for reuse outside of the EU (mainly Africa), where other minimum tread depths
430 may apply. However, the long-distance transport causes reuse in the Netherlands to be the least
431 environmental option in waste tyre treatment.

432 Figure 4 shows that the potential for local reuse and retread in the Netherlands has room for improvement
433 compared to Belgian and Italian rates. However, the predominant treatment of waste tyres in 2015 in the
434 Netherlands was export (48%). This was to the detriment not only of local reuse, but also led to the lowest rate
435 of material recovery in 2015. The highest material recovery rates are achieved by Belgium, which may be
436 attributed to the high material recovery target. Italy has the highest local reuse and retread rates, but by far
437 the highest energy recovery rates. This may be traced back to the incentive for garages to sort out tyres fit for
438 reuse and retread and the lack of treatment targets.

439 5.2.3 Single versus Multiple PROs

440 While Belgium and the Netherlands have no competition on the PRO-level, Italy clearly does with 37 PROs in
441 operation. The legal framework will have an influence on the formation of a single or multiple PROs. If
442 legislation does not require the formation of multiple PROs, it is likely that a single PRO will form, as this is the
443 dominant case in the EU (see Table 1).

444 6 Conclusions: Lessons Learnt

445 The basic layout of most EPR systems for waste tyres consists of a take-back obligation in combination with an
446 advanced disposal fee. The take-back obligation makes the producer physically responsible, the fee, financially.

Many systems opted to implement the advanced disposal fee as a visible fee, which bears the advantages of being transparent to the consumer as well as helping in the detection of free-riders.

In general, the main goals of EPR are increased waste collection, waste reduction, resource efficiency and eco-design. Based on the case studies, EPR for tyres is partially successful in regards to these. No conclusive evidence could be found that EPR for tyres leads to waste reduction improvements. Eco-design has not been furthered by EPR for tyres either. However, EPR for tyres has been found to promote resource efficiency by increasing recycling and thus potentially replacing virgin material through recyclates. EPR for tyres has also been successful at increasing collection rates. Overall, EPR for tyres has been found to be a useful tool in order to:

1) Reduce flytipping and illegal stockpiling:

The consulted literature as well as the research on the case studies strongly suggest that EPR is the best available option in order to prevent future illegal disposal, as well as aiding in the removal of historical illegal stockpiles. This is achieved through increased collection.

2) Increase resource efficiency:

The research suggests that in order to achieve high resource efficiency, legal targets for material recovery should be provided. This is underlined by the Italian case, which has no legal material recovery targets and exhibits the highest energy recovery rate among the case studies.

3) Move up the waste hierarchy:

EPR has the potential to move waste tyre treatment up the waste hierarchy. However, reuse and retread are environmentally only desirable, if the local reuse and retread tyre market can be expanded. Once tyres are exported, their environmental performance significantly decreases. Furthermore, tyres would need to be exported outside of Europe, and therefore likely to enter countries with less stringent waste regulation. This in turn may lead to tyre waste management at the very bottom of the waste hierarchy. Thus, it is argued that for

470 the case of waste tyres, recycling is the most desirable waste treatment option after local reuse and retread
471 peaks.

472 The case studies suggest that the main tools to move up the waste hierarchy are:

473 a) *Quantitative targets:*

474 Clear goals are necessary, but quantitative targets are essential to reach those goals. From the
475 examined case studies the one with quantitative targets (Belgium) achieved the best results. Which
476 suggests that such targets influence treatment performance. Therefore, targets for material recovery
477 should be defined. A cap on less desired treatment methods (e.g. energy recovery) may need to be
478 imposed to achieve best results.

479 A take-back obligation should be supported by a collection target of 100%.

480 b) *Precise definition of waste status:*

481 A clear definition of when a tyre becomes waste within the legislation seems to have the potential to
482 maximize local reuse and retread. The Italian legislation is a good example for this practice, where the
483 design of the legislation incentivizes garages to capitalize on reuse and retread, leading to the highest
484 local and lowest export for reuse and retread rates.

485 The cases of both Italy and the Netherlands show that an EPR system is no guarantee for waste treatment in
486 the most environmentally sound way. An EPR system will only achieve its objectives if properly designed,
487 implemented and enforced. From the cases studied, PROs are likely to seek out the most economical
488 treatment option within the legislative framework. The most economical solution seemingly being energy
489 recovery in Italy and export for reuse or retread in the Netherlands. Therefore, it is advisable to clearly target
490 the most desired treatment within legislation.

491 Two general approaches to set up EPR systems for tyres have been identified. First is the inclusive approach of
492 Belgium, where the legislation sets general principles and the specifics of the system are agreed upon with the
493 sector periodically. This approach has the advantage to offer great flexibility in adjusting or introducing new

494 targets. For example the inclusion of historical stocks into the scope of the system can be phased in, if the
495 sector is initially reluctant to accept responsibility for historical stocks. However, as is apparent from the
496 current situation with the collectors, a legal mechanism allowing the government to enforce minimal
497 conditions of an agreement is advisable.

498 Second is the Italian model of strong and clear legislation imposing the government's goals on the sector. The
499 advantages of the Italian system are virtual elimination of free-riding and the inclusion of historical stocks.
500 However, if no material recovery targets are added, it is likely that energy recovery rates remain relatively
501 high.

502 Municipal infrastructure remains necessary for collection, clean-up of illegally disposed tyres and the
503 abatement of historical stocks (except for Italy) and their costs are not always covered by the EPR system.
504 Although municipalities are legally not obliged to collect tyres in any of the case studies, most voluntarily
505 continue to do so, as civic amenity sites are viewed as collection points by the public. Collection at civic
506 amenity sites is perceived as convenient by holders of waste tyres and discourages illegal disposal. Integrating
507 municipal collection into the EPR system including adequate financial compensation has the potential to
508 minimize cost to tax-payers. Furthermore, the wider the scope of tyre types included in the legislation (as in
509 Belgium or Italy), the less cost to tax-payers. As the Dutch case shows, a narrow scope has the potential for
510 PROs exploiting their strong position on the market by charging for the collection of any tyre outside of the
511 scope. This may lead to an increased financial burden to municipalities and businesses, as well as be an
512 obstacle in the abatement of historical stocks. None of the investigated EPR systems can be deemed full-cost
513 recovery. Thus, shifting the financial burden in full from the tax-payer to the polluter (i.e. the tyre producer
514 and the user of tyres) has not been achieved in the studied cases.

ACKNOWLEDGEMENTS:

We would like to thank Christof Delatter (VVSG) for his advice along the way; ETRMA for explaining the data; the interview partners at NVRD, VVSG, OVAM and the Italian Public Authority; Wim Van Breuseghem; as well as Leila Baganha Rabelo and Ben Loder for proof-reading.

7 References

- ARN advisory, FFact, 2011. ecotest Brochure [WWW Document]. URL https://www.recybem.nl/sites/recybem.nl/files/user/ecotest_2011-english.pdf (accessed 4.15.18).
- Bakas, I., 2013. Municipal waste management in Cyprus [WWW Document]. ETC/ECP working paper for EEA member country review. URL [a10c9df4747e4733b007a14bd391fb96](https://www.recybem.nl/sites/recybem.nl/files/user/ecotest_2011-english.pdf) (accessed 1.30.18).
- Bell, K., Cave, S., 2010. Tyre Disposal [WWW Document]. Res. Libr. Serv. Brief. Note. URL <http://www.niassembly.gov.uk/globalassets/Documents/RaISe/Publications/2010/Environment/15910.pdf> (accessed 1.29.18).
- Boyle, G. (Ed.), 2012. Renewable Energy: Power for a Sustainable Future, 3rd ed. Oxford University Press, Oxford.
- EcoAnvelope, 2018. ECO ANVELOPE S.A. - Societate de Gestiune a Fluxului Anvelopelor Uzate [WWW Document]. URL <http://www.ecoanvelope.ro/desprenoi.htm> (accessed 3.7.18).
- Ecopneus, 2018. Ecopneus [WWW Document]. URL <http://www.ecopneus.it/en> (accessed 3.14.18).
- Ecotest, 2013. Over ons | Ecotest.nu [WWW Document]. URL <http://ecotest.nu/over-ons/> (accessed 1.14.19).
- EEA, 2016. Country Profile Hungary [WWW Document]. EEA Rep. More from less — Mater. Resour. Effic. Eur. 2015 Overv. policies, instruments targets 32 Ctries. URL [5489c3d3eefb4f07976ffd1bd43b3de5](https://www.recybem.nl/sites/recybem.nl/files/user/ecotest_2011-english.pdf) (accessed 1.31.18).
- ETRMA, 2018. Personal Communication on 15 March. European Tyre & Rubber Manufacturers' Association, Brussels.
- ETRMA, 2017a. Annual Report 2017: Moving innovation that cares [WWW Document]. Annu. Rep. URL <http://www.etrma.org/uploads/Modules/Documentsmanager/20170905---etrma-annual-report-2016->

17---final.pdf (accessed 2.11.18).

ETRMA, 2017b. ETRMA 2015 ELT Management figures [WWW Document]. URL

http://www.etrma.org/uploads/Modules/Documentsmanager/2017-01-25_2015-elt-data_final.pdf

(accessed 2.11.18).

ETRMA, 2017c. ETRMA 2014 ELT Management figures [WWW Document]. URL

[http://www.etrma.org/uploads/Modules/Documentsmanager/2017-01-25_2014-elt-data_final-\(2\).pdf](http://www.etrma.org/uploads/Modules/Documentsmanager/2017-01-25_2014-elt-data_final-(2).pdf)

(accessed 2.11.18).

ETRMA, 2011. End of life tyres: A valuable resource with growing potential. 2011 edition [WWW Document].

URL <http://www.etrma.org/uploads/Modules/Documentsmanager/brochure-elt-2011-final.pdf> (accessed

2.20.18).

European Council, 1989. Council Directive 89/459/EEC of 18 July 1989 on the approximation of the laws of the

Member States relating to the tread depth of tyres of certain categories of motor vehicles and their

trailers. European Economic Community.

Gov. Italy, 2011. Ministerial Decree no. 82 of 11th April 2011 [WWW Document]. URL

http://www.ecopneus.it/_public-file/DM_82_2011_EN.pdf (accessed 4.17.18).

Gov. NL, 2009. Besluit beheer autobanden, BWBR0016038. Ministerie van Volkshuisvesting, Ruimtelijke

Ordering en Milieubeheer [WWW Document]. URL [http://wetten.overheid.nl/BWBR0016038/2009-05-](http://wetten.overheid.nl/BWBR0016038/2009-05-01/0/informatie)

[01/0/informatie](http://wetten.overheid.nl/BWBR0016038/2009-05-01/0/informatie) (accessed 4.23.18).

Gov. of the Rep. of Croatia, 2017. Waste Management Plan of the Republic of Croatia for the Period 2017-2022

[WWW Document]. URL

[http://www.mzoi.hr/doc/management_plan_of_the_republic_of_croatia_for_the_period_2017-](http://www.mzoi.hr/doc/management_plan_of_the_republic_of_croatia_for_the_period_2017-2022.pdf)

[2022.pdf](http://www.mzoi.hr/doc/management_plan_of_the_republic_of_croatia_for_the_period_2017-2022.pdf) (accessed 3.7.18).

- Gov. of the Rep. of Croatia, 2007. Waste Management Plan in the Republic of Croatia for the Period from 2007 to 2015 [WWW Document]. URL http://mzoip.hr/doc/waste_management_plan_og_85-207.pdf (accessed 3.7.18).
- Huang, H., Tang, L., 2009. Pyrolysis treatment of waste tire powder in a capacitively coupled RF plasma reactor. *Energy Convers. Manag.* 50, 611–617. <https://doi.org/10.1016/j.enconman.2008.10.023>
- Lindhqvist, T., 2000. Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product Systems [WWW Document]. URL <http://lup.lub.lu.se/search/ws/files/4433708/1002025.pdf> (accessed 2.2.18).
- Martínez, J.D., Puy, N., Murillo, R.N., García, T.S., Navarro, M.V., Mastral, A.M., 2013. Waste tyre pyrolysis - A review. *Renew. Sustain. Energy Rev.* 23, 179–213. <https://doi.org/10.1016/j.rser.2013.02.038>
- Monier, V., Mathieu Hestin, Jérémie Cavé, Ilse Laureysens, Emma Watkins, Hubert Reisinger, Lucas Porsch, 2014. Development of Guidance on Extended Producer Responsibility (EPR) [WWW Document]. URL [http://ec.europa.eu/environment/archives/waste/eu_guidance/pdf/Guidance on EPR - Final Report.pdf](http://ec.europa.eu/environment/archives/waste/eu_guidance/pdf/Guidance%20on%20EPR%20-%20Final%20Report.pdf) (accessed 1.17.18).
- NVRD, 2018. Personal Communication on 18 April. Koninklijke Nederlandse Vereniging voor Reinigings- en Afvalmanagement, Arnhem.
- OECD, 2016. Extended Producer Responsibility: Updated Guidance for Efficient Waste Management. OECD Publishing, Paris. <https://doi.org/10.1787/9789264256385-en>
- OECD, 2001. Extended Producer Responsibility: A Guidance Manual for Governments. OECD Publishing, Paris.
- OVAM, 2018. Personal Communication on 22 March. Public Waste Agency of Flanders, Mechelen.
- Public Authority, 2018. Personal Communication on 30 March. Italian Stakeholder, Italy.
- RecyBEM, 2019. Ecotest | RecyBEM B.V. en Vereniging Band & Milieu [WWW Document]. URL

<https://www.recybem.nl/en/about-recybem/environmental-performance/ecotest> (accessed 1.14.19).

RecyBEM, 2013. Tyre & Environment [WWW Document]. URL

https://www.recybem.nl/sites/recybem.nl/files/user/magazine_tyre_and_environment_2013.pdf
(accessed 3.14.18).

Recytyre, 2018. Wat is Recytyre? [WWW Document]. URL <http://www.recytyre.be/nl/over-recytyre/wie-is-recytyre> (accessed 4.13.18).

Recytyre, 2016. Jaarverslag 2016 [WWW Document]. URL http://www.recytyre.be/media/88905/nl_jaarverslag_recytyre_-_16-06-2017.pdf (accessed 4.13.18).

Recytyre, 2015. Jaarverslag 2015 [WWW Document]. URL http://www.recytyre.be/media/88546/jaarverslag_2015.pdf (accessed 4.14.18).

Recytyre, 2014. Jaarverslag 2014 [WWW Document]. URL http://www.recytyre.be/media/80694/jaarverslag_2014.pdf (accessed 4.14.18).

SAIC Energy, E.& I., 2012. Evaluation of Tire Incentive and Extended Producer Responsibility Policies [WWW Document]. URL www.calrecycle.ca.gov/Publications/ (accessed 1.29.18).

Scott, E., 2016. End-of-life Tyre REPORT 2015 [WWW Document]. URL

<http://www.etrma.org/uploads/Modules/Documentsmanager/elt-report-v9a---final.pdf> (accessed 2.5.18).

SektionV, 2017. Bundes-Abfall- Wirtschaftsplan 2017. Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Vienna.

Sienkiewicz, M., Kucinska-Lipka, J., Janik, H., Balas, A., 2012. Progress in used tyres management in the European Union: A review. *Waste Manag.* 32, 1742–1751.

<https://doi.org/10.1016/J.WASMAN.2012.05.010>

- Silke Krömer, Eckhard Kreipe, Diethelm Reichenbach, Rainer Stark, 1999. Life Cycle Assessment of a Car Tyre [WWW Document]. URL <https://www.continental-corporation.com/resource/blob/47500/b64cfd62d7c37b31e0141cb618756f86/oekobilanz-en-data.pdf> (accessed 1.14.19).
- Torretta, V., Rada, E.C., Ragazzi, M., Trulli, E., Istrate, I.A., Cioca, L.I., 2015. Treatment and disposal of tyres: Two EU approaches. A review. *Waste Manag.* 45, 152–160.
<https://doi.org/10.1016/j.wasman.2015.04.018>
- Uruburu, Á., Ponce-Cueto, E., Cobo-Benita, J.R., Ordieres-Meré, J., 2013. The new challenges of end-of-life tyres management systems: A Spanish case study. *Waste Manag.* 33, 679–688.
<https://doi.org/10.1016/j.wasman.2012.09.006>
- Van Breusegem, W., 2009. The principle of Extended Producer Responsibility, for Bruxelles Environnement. Brussels.
- Van Breusegem, W., Gonser, J., 2017. Implementation of the Shared Environmental Information System principles and practices in the Eastern Partnership countries (SEIS II East) - waste statistics; Waste Statistics Guidance: Waste Management Glossary. Brussels.
- VVSG, 2018. Personal Communication on 29 March. Association of Flemish Cities and Municipalities, Brussels.
- WBCSD, 2010. End-of-Life Tires: A framework for effective management systems. Appendix [WWW Document]. URL <http://www.etrma.org/uploads/Modules/Documentsmanager/appendices-a-framework-for-effective-elt-management-systems-final-25.6.10.pdf> (accessed 2.16.18).

Tables & Figures:

Table 1 Number of PROs per EU-Member State (EPR – Extended Producer Responsibility; PRO – Producer Responsibility Organization)

Member States	One PRO		Multiple PROs (number of PROs)	Governmentally organized EPR
	Belgium Czech Republic Estonia (used to have two PROs, but one recently went out of business) Finland Greece Ireland	Lithuania Netherlands Portugal Romania Slovakia Slovenia Sweden	Bulgaria (?) France (2) Italy (37) Poland (?) Spain (2)	Croatia Hungary

(?) Multiple PROs, but no information could be attained on how many PROs exactly.
Based on (ETRMA, 2018; Uruburu et al., 2013)

Table 2 Life Cycle Assessment (LCA) evaluation of treatment methods in the Netherlands

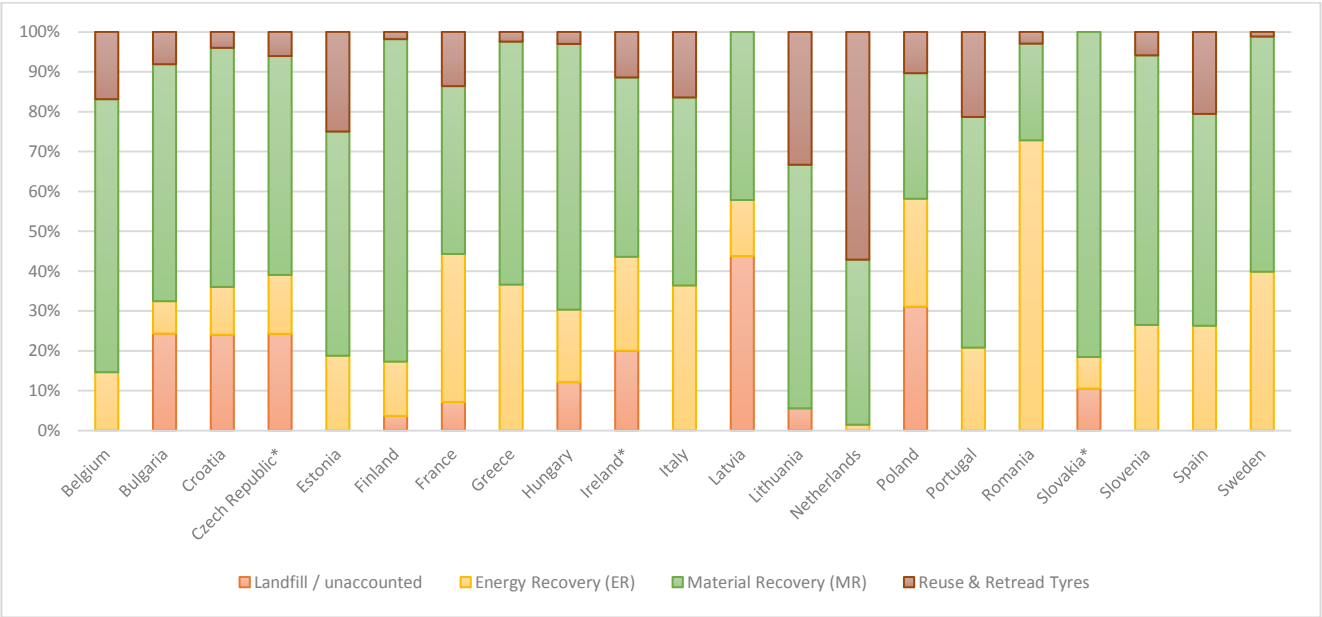
per tonne waste tyres	Export for Reuse/Retread	Local Retread	Recycling	Energy Recovery	
				Combined Heat & Power	Cement Kilns
CO₂e savings	727kg	2,330kg	1,050kg	940kg	954kg
Material or energy savings for production of a new tyre	20%	85%	80%	15%	15%
Cost	130€	150€	220€	180€	190€

From: (ARN advisory and FFact, 2011)

Table 3 Comparison of Scope and Targets of the Belgian, Italian and Dutch Extended Producer Responsibility for tyres legislation (ELV – end-of-life vehicles)

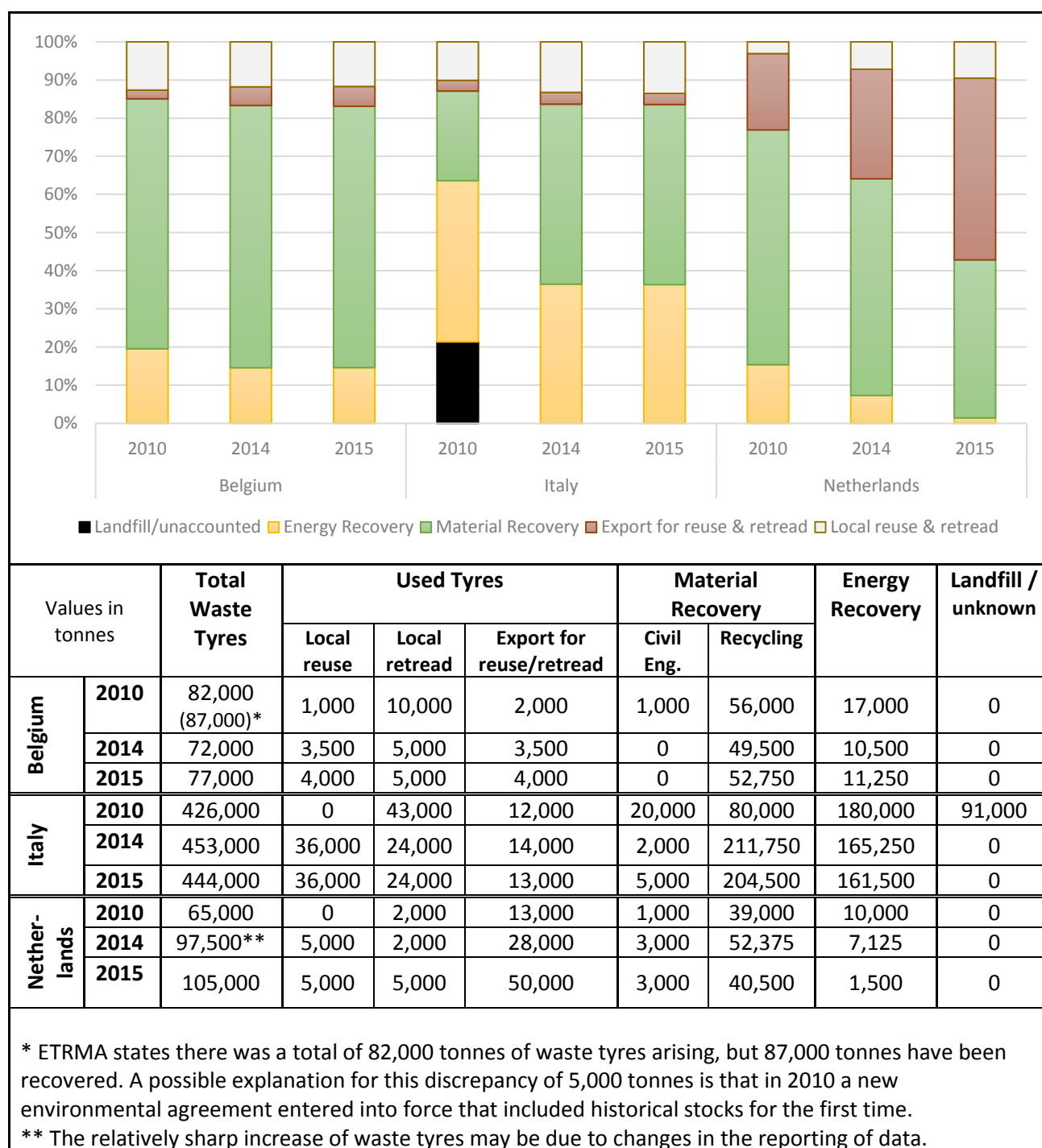
		Belgium	Italy	Netherlands
Scope of the EPR system: Types of Tyres in legislation	Bicycle tyres			
	Motorcycle tyres	x	x	
	Passenger car tyres	x	x	x
	Trailers of light vehicles	x	x	x
	Bus tyres	x	x	
	Truck tyres	x	x	
	Off-the-road tyres (agricultural and industrial)	x	x	
	Aeroplane tyres	x		
	ELV (original equipment) tyres	x*	x	
	Historical stocks	x**	x	
Legal Targets	Collection target	100%	100%	100%
	Material Recovery target (incl. reuse and retread)	min. 55%	-	20% legally; 90% voluntarily
	Energy Recovery target	max. 45%	-	-
<i>x – included in scope; *since 2010; **partially included</i>				

Figure 1 Waste tyre treatment under Extended Producer Responsibility in the European Union in 2015



From: (ETRMA, 2017b)

Figure 2 Waste tyre treatment in Belgium, Italy and the Netherlands



From: (ETRMA, 2017b, 2017c, 2011)

Figure 3 Waste status for tyres according to Italian legislation (ELT – end-of-life tyre; ELV – end-of-life vehicle)

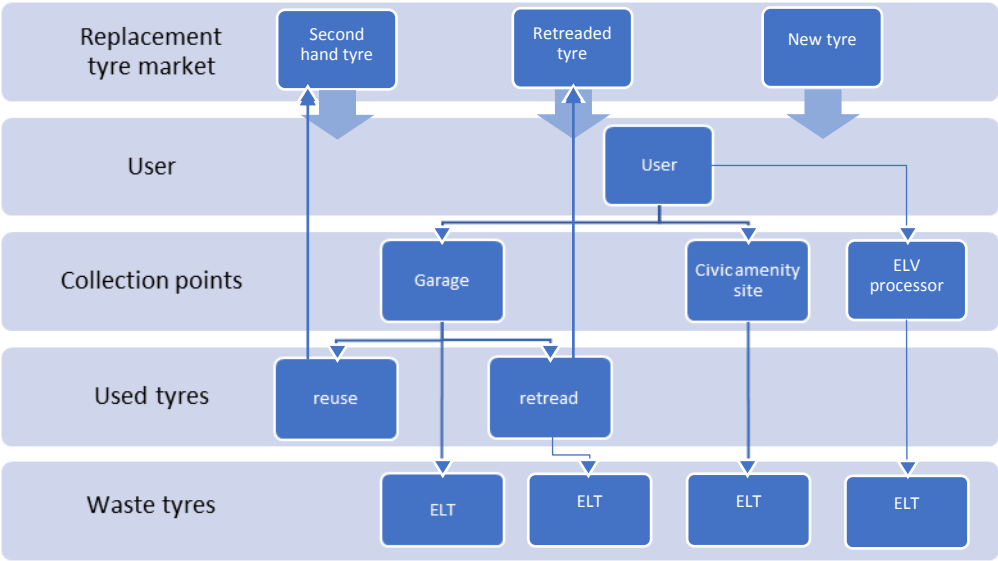
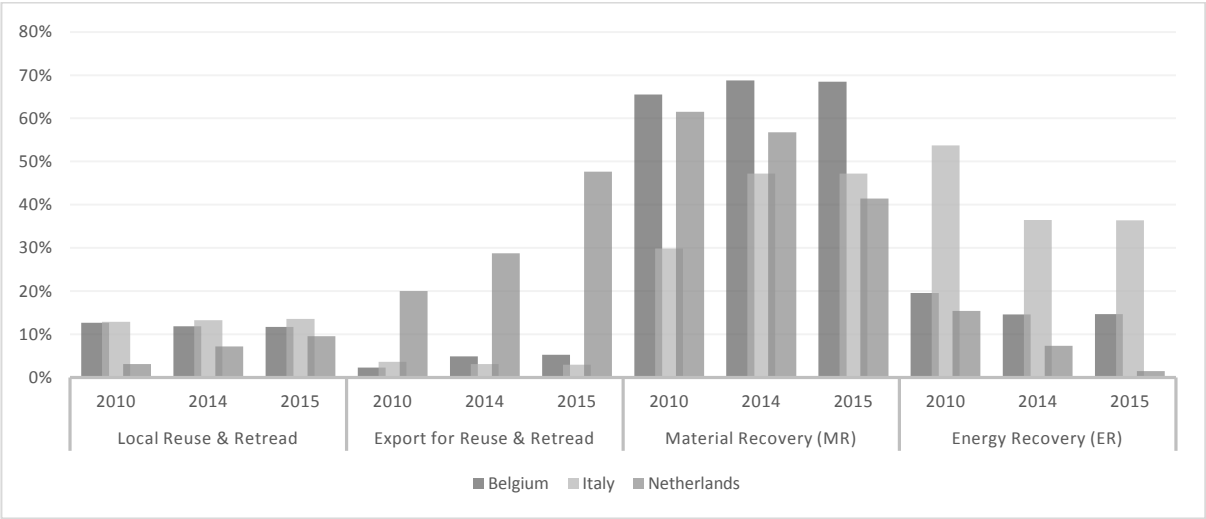


Figure 4 Comparison of treatment rates in Belgium, Italy and the Netherlands



From: (ETRMA, 2017b, 2017c, 2011)